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ABSTRACT

To examine the role of phonetic code in memory, a study investigated the use of phonetic recoding strategies in fifth and sixth graders identified as good and poor readers. Subjects--120 students with IQ scores in the average range--were divided evenly between both grades. Thirty subjects from each grade who scored above the 50th percentile on the California Achievement Test were selected as good readers, and 30 subjects from each grade who scored below the 50th percentile were designated as poor readers. Students were individually tested in two separate sessions separated by one week. For the visual input condition, students were shown 28 monosyllabic words one at a time, asked to say each word aloud, and told to remember each word shown. A second set of words was presented one at a time; students replied "yes" if they thought the word was on the previous list, or "no" if they thought the word was not on the previous list. For auditory presentation the initial set of words was presented verbally and the recognition list presented visually. Word pairs were classified as phonetically similar if they shared the same vowel sound and differed by no more than three consonantal phonetic features. Results indicated that good and poor readers made equivalent numbers of recognition errors on phonetically similar and dissimilar items. Groups could not be distinguished by their use of a phonetic code in working memory. (One table is included, and 31 references are appended.) (MM)

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RUNNING HEAD: Phonetic Recoding

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Phonetic Recoding Ability and Reading Proficiency in Fifth and Sixth Grade Readers

Abstract

Although recent research has suggested that phonetic recoding is an essential component of reading, these studies contain a number of methodological problems which limit their utility. A major limitation is the failure to examine phonetic recoding by older readers. This study examines the use of phonetic recoding by children 11 to 13 years of age. Using a four-factor mixed design ANOVA involving reading ability, age level, input modality, and phonetic similarity/dissimilarity of items the anticipated phonetic confusability effect for skilled readers was not found. A reliable main effect for input modality was identified. Findings are examined relative to the use of alternative encoding mechanisms by both older skilled and unskilled readers.

Phonetic Recoding Ability and Reading Proficiency in Fifth and Sixth Grade Readers

There are few apparent differences between good and poor readers in speaking and understanding language, yet some argue that there are subtle differences in language usage that do not become evident until reading begins. Identifying these differences could provide for a more complete understanding of reading and generate specific interventions to remedy the problems of poor readers.

Some research indicates that good and poor readers differ in their ability to represent words phonetically in working memory (Liberman, Shankweiler, Liberman, Fowler, & Fischer, 1977; Katz, Shankweiler, & Liberman, 1981). These findings suggest that good readers rely on a phonetic code during storage, while poor readers do not. Use of a phonetic code means that the reader converts script into its corresponding phonemic representation. Once the phonemic characteristics have been decoded, integrated and retained, then meaning is assigned. The experimental paradigm used by Mark, Shankweiler,

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Liberman, and Fowler (1977) typifies how this problem has been studied. They presented phonetically similar and dissimilar word pairs to good and poor reading second graders. During recall good readers were penalized more than poor readers by the phonetically similar words. Shankweiler, Liberman, Mark, Fowler, & Fisher (1979) found similar results with second graders for recall of phonetically similar and dissimilar letter strings. Mann, Liberman, and Shankweiler expanded upon this paradigm by presenting rhyming and non-rhyming sentences to 30 good and poor second grade readers. Results consistently showed that good readers were penalized more than poor readers during recall for phonetically similar stimuli.

Studies examining syllabic and phonetic analysis skills of good and poor readers offer another source of support for the phonetic recoding hypothesis as a primary mechanism involved in proficient reading. Fox and Routh (1976) found phonic blend training improved the ability to make letter-sound correspondences for four-year olds who were proficient with phonetic analysis. The data were seen to indicate that awareness of the phonemic structure of words is necessary for phonetic coding to occur. Stanovich (1981) measured the speed at which good and poor readers named colors, pictures, numbers,

letters, and words. Words were the only stimuli that good readers named more rapidly. Again, it was concluded that phonetic analysis skills seemed to be important determinants of early reading proficiency.

Lean and Arbuckle (1984) studied phonetic recoding with four to six year olds who could name letters but not read. Using a serial free recall letter-naming task they found that both overall recall capacity and serial ordering were adversely affected by phonetically similar items. They proposed that preschoolers code visually presented letters as verbal labels even when it penalizes recall. They hypothesize further that phonetic coding is advanced enough by age four to be used as a memory strategy for both item and order memory, with no developmental effects expected.

There have been few studies examining a developmental effect associated with use of a phonetic code, especially with children who have reached the formal operations level of cognitive development. Alegria and Pignot (1979) identified a recall similarity effect for kindergarteners, but not for fourth graders. They suggested that older children may use another strategy completely or concurrently with phonetic recoding. Since older readers read longer segments of material they may

not rely as heavily, if at all, on letter-sound correspondences during reading as would younger readers.

Do children develop alternative memory strategies as they become more proficient in reading? Is the phonetic similarity effect constant for all age levels and related strictly to level of reading skill? Conrad (1971) examined one aspect of these issues. Children ranging in age from 4 to 9 years were presented with pictures for free recall. Picture names were rhyming and non-rhyming. Children younger than age six did not show any recall differences based on item confusability. Recall differences did appear in favor of the non-rhyming set for those older than 6 years. Algeria and Pignot (1979) found similar results with four year olds. Evidently, by age six most children use a phonetic code in working memory. The question of its presence and importance in older children remains speculative.

Brown, Sanocki, and Schrot (1983) investigated phonetic coding by marginally competent readers of mean age 8.5 years. They wanted to assess the effect of input modality (visual and auditory) and avoid the floor effect characteristic of some studies (Shankweiler, Liberman, Mark, Fowler, & Fischer, 1979). They found that the low-phonetic/ high-phonetic recall

difference was greater for auditory input than with visual input. Visual presentations may encourage alternative coding strategies. If children have developed equal proficiency with phonetic coding as well as with alternative memory codes, then there may be a match between the way the information is presented with the coding strategy which best meets efficient memory processing requirements. While these data support those obtained with young readers, they also suggest that the phonetic coding deficit shown by subaverage readers is not as pervasive as indicated. This might be due to the older age of the subjects, cognitive maturation or development of multiple memory codes. With increasing age different coding strategies may be used, particularly for visually presented materials.

Besner and Davelaar (1982) hypothesize the existence of at least two types of phonetic memory codes. One code maintains phonetic information in STM, while the other accesses lexical meanings. Besner, Davies, and Daniels (1981) suggest that one of these phonetic codes is affected by suppression of rehearsal processes, while the other is not.

These hypotheses are readily integrated with the findings from adult studies on use of phonetic coding. Peterson and Johnson (1971) identified recall similarity effects with

undergraduates when stimuli were presented aurally but not when presented visually. The subjects may have used a lexical access code to compensate for phonetic coding inefficiencies. Early studies (Conrad, 1964; Wickelgren, 1965) on the use of phonetic codes by adults used primarily auditory input for stimuli, which could have precluded examination of a second type of phonetic code.

Chastain (1981, 1986) investigated phonetic recoding with adults and concluded it takes place when task demands indicate its appropriateness. Yet, Chastain's task precluded the use of any other encoding strategy since he used only letters that were graphemically similar. Certainly, such task demands dominate much of the research supporting the phonetic coding hypothesis.

Waters, Komoda, and Arbuckle (1985) investigated use of phonetic codes where adults were asked to read and comprehend prose passages while performing concurrent tasks. They found that shadowing had the potential to interfere with the use of phonological codes, but not with the rest of normal reading. They suggest that the processes involved in reading do not change as the material becomes more difficult. This conclusion is based on the absence of an interaction effect between passage difficulty and separate interference conditions expected to

affect phonological recoding. Reading may involve visual codes or some other form of non-phonetically based code. This is not to say phonetic codes are never used. But, they may play a minor role in skilled reading.

Bisanz, Das, and Mancini (1984) found differential use of phonetic codes by good and poor readers in grades four and six to be less than that found with younger children. A similar conclusion was reached by Johnston (1982). Thus, failure to demonstrate this effect across all age levels refutes the hypothesis that good and poor readers can be reliably differentiated by use of phonetic recoding.

In addition to the task demands noted earlier, many studies supporting the phonetic coding hypothesis fail to examine the impact of between-group differences in intelligence on recall capacity. Academic characteristics of the contrasted groups are often glossed over. Finally, some studies examine recall and recognition memory, but fail to give participants adequate instructions encouraging them to retain word lists they are shown (Mark, Shankweiler, LIberman & Fowler, (1977).

If the importance of phonetic recoding diminishes, is replaced, or is built-upon by another type of code, at what

point in development does the change occur? Do phonetic confusability effects hold for fifth and sixth graders when stimuli are presented visually or has it already been replaced by an alternative memory strategy?

This study investigates the use of phonetic recoding strategies in fifth and sixth graders identified as good and poor readers. If differences between groups in the use of phonetic recoding exist and are consistent with findings for younger readers, it may be concluded that phonetic coding remains critical to reading regardless of age and reading skill level. If between-group differences are diminished or non-existent, the inference is that different strategies are used by older students. The phonetic code no longer maintains its primary role in memory.

Method

Subjects:

A stratified random sampling procedure was used to select participants from fifth and sixth grade classes. All students in these grades were administered a group IQ test, the Test of Cognitive Skills (1981). Students with IQ scores in the average range were then rank ordered according to their national percentile rank on the Total Reading section of the California

Achievement Test (1977). Thirty subjects from each grade who scored above the 50th percentile were randomly selected as good readers and 30 from each grade who scored below the 50th percentile were designated as poor readers.

Design:

A 2 x 2 x 2 x 2 mixed ANOVA design was used to identify between-group differences. Independent variables were: reading ability of the student (good reader, poor reader); grade level of the student (fifth, sixth); phonetic confusability of the stimulus words (similar, dissimilar); and input modality to present words (visually, aurally). The last two factors were repeated measures. The dependent variable was the total number of errors made in recognizing phonetically similar/dissimilar word lists. Significant effects were further examined for simple mean differences using the Newman-Keuls procedure.

Procedures:

Students were individually tested in two separate sessions separated by one week to minimize practice effects. All testing was conducted using a completely balanced design.

For the visual input condition, participants were told that 28 words would be shown one at a time and that they should say each word aloud. Five seconds were allotted for recognition.

If the participant was unable to identify the word, it and its corresponding foil word were eliminated only for that child. Because of the familiarity of the words used in this procedure, no words were eliminated. The child was specifically told to try to remember each word shown. The experimenter recorded all words read correctly on a separate sheet.

Recognition List: A second set of words written on 3 x 5 white cards was presented one at a time. The participant read the word aloud and replied "yes" if he believed the word was on the previous list, or "no" if he believed the word was not on the previous list.

For the auditory presentation the initial set of words was presented verbally and the recognition list presented visually. Word pairs were classified as phonetically similar if they shared the same vowel sound and differed by no more than three consonantal phonetic features in the set of "place," "manner," "voicing," and "nasality" (Wicklegren, 1965; Mark, Shankweiler, Liberman, & Fowler, 1977). If a pair of words failed to meet these criteria they were considered phonetically dissimilar.

The word lists consisted of monosyllables chosen from Part 1 of the Cheek Master Word List (Cheek, 1974). The words were limited to first grade level to insure that poorer readers could

recognize them. The initial list was composed of 28 words. The recognition list was composed of the 28 words on the initial list and an equal number of words serving as foils not on that list. Fourteen foils were paired phonetically with a word on the initial list. These were the phonetically similar items. The phonetically similar foils were also distinct in their visual configuration from words on the initial list to avoid the potential confound of subjects responding to the visual appearance of the word. The remaining fourteen foils were both phonetically and visually dissimilar to words on the initial list.

Each word was hand printed in lower case block letters on white 3 x 5 inch cards, using a black felt tip pen. The short letters were .50 inches high, the tall letters 1.0 inches high.

Results

The mean number of recognition errors for all treatment groups is presented in Table 1. The four way mixed ANOVA identified a reliable main effect for input modality, with participants making significantly more recognition errors with aural input than with visual input [$F(1,56) = 138.76$, $p<.001$]. No other main or interaction effects were reliable. Newman-Keuls comparison tests for simple mean differences

revealed significance at the .01 level for every comparison. That is, input modality was significant for each comparison regardless of whether participants were fifth or sixth graders, good or poor readers, or had received phonetically similar or dissimilar word lists.

Insert Table 1 here

Previous research has shown the phonetic confusability effect to be most prominent when stimuli are presented aurally. Comparing the number of recall errors made for auditory presentation of phonetically similar and dissimilar words failed to reveal reliable between-group differences for the phonetic confusability effect. All groups made approximately equal numbers of recall errors and none were penalized by the phonetic confusability factor.

Discussion

These data indicate that good and poor readers made equivalent numbers of recognition errors on phonetically similar and dissimilar items. Groups could not be distinguished by their use of a phonetic code in working memory. It may be that phonetic recoding is a developmental phenomenon that diminishes

with age as Olsen, Davidson, Kliegl, & Davies (1984) have suggested. Phonetic recoding has been shown to differentiate good from poor beginning readers. But increasing evidence indicates that it is not characteristic of older good and poor readers (Olsen, Davidson, Kliegl, & Davies, 1984; Bisanz, Das, & Mancini, 1984).

The phonetic code may facilitate recall during beginning reading, and perhaps, aids the older reader when reading unfamiliar material. But, it does not appear essential for skilled reading at older ages. Rather, different coding processes may be involved which supplant this recoding strategy.

The significant effect for input modality implies that a visual code may have been accessed which aided recognition. It could be that when older readers visualize information they can encode it more rapidly or in a way conducive to more efficient recall. The visual representation may also contribute to use of other lexical access codes (Besner, Davies & Daniels, 1981; Besner & Davelaar, 1982).

All groups made fewer recognition errors when stimuli were presented visually rather than aurally. The possibility exists that the sample of students consisted primarily of visual

learners. However, in reviewing individual test protocols it was found that every participant made fewer recall errors in the visual input modality. It seems unlikely that every student would be a visual learner.

Previous research indicates that phonetic recoding is used by young readers regardless of type of reading instruction (Alegria, Pignot & Morais, 1982). A phonic approach and a whole-word approach were shown to have no differential effect on use of phonetic recoding (Alegria, Pignot & Moraise, 1982). Therefore, it also seems unlikely that type of instructional experiences would have produced the significant modality effect.

The most plausible interpretation seems to be that participants used more than one type of encoding strategy with visual input. Other encoding strategies involving orthographic, phonetic, and word meaning cues may have been relied upon during recall. Also, participants were required to pronounce the word while reading it which created a double-input modality effect. It is possible that the double-input offered additional repetition facilitating recall. Craik and Tulving (1975) have shown that visual features do influence how well material can be remembered and hypothesize that, in combination with other codes, this may improve recall. Nelson and Borden (1977) have

shown that cues which are both visually and semantically related to their targets (e.g., 'cost' cueing 'cash') are more effective than semantic cues alone (e.g., 'price' cueing 'cash'). In short, the more elaborate the memory trace, the greater the probability of recall (Craik & Tulving, 1975). It seems likely that double-input effects were an important contributor to the main effect of input modality.

The findings from this research indicate that good and poor readers in the fifth and sixth grades cannot be differentiated by their use of a phonetic code in working memory. Good and poor first and second graders have consistently been shown to differ in their use of a phonetic code in working memory. Evidently phonetic recoding begins to lose its significance sometime during the third and fourth grades. By fifth grade, the phonetic code clearly does not distinguish good from poor readers.

Use of a phonetic code in beginning readers could be a function of the early readers reliance on the linguistic characteristics of the words. Since a younger child has a very large listening vocabulary and a very small reading vocabulary (Zintz, 1977), the child could be expected to encode words in a way he is most familiar with and comfortable. That would be a

verbal or language based code. As the child proceeds through school his reading vocabulary expands. By grade five, the able reader's reading vocabulary exceeds the speaking vocabulary (Zintz, 1977). It would be more pragmatic for the reader to implement an encoding strategy specific to reading rather than one based on language or the phonetic characteristics of words - especially with the increasing number of phonetically irregular words that are part of the reading vocabulary.

As comprehension becomes the measure by which good and poor readers are distinguished (as opposed to decoding skill) it becomes essential that the reader decode words rapidly and hold larger amounts of information in STM. The gist of the message can then be extracted and translated into a brief message statement. A phonetic code may demand much more of STM than other types of codes. If a phonetic code was used, and a long sentence read, a heavy load would be placed on STM since each word would be composed of one or more phonetic structures. On the other hand, a visual code might enable the reader to "visualize" a group of words that could be encoded as one bit of information (for example, "It is / a nice day"). In the phonetic form this sentence may occupy five or more bits of STM

capacity. The visual code would place less strain on STM and allow the reader more STM space for comprehension.

Research by Andrews (1982) who offers a dual access model to reading, supports this hypothesis. The dual-access model holds that lexical access is attempted in parallel on the basis of visual and phonological codes and the response is determined by the route that first reaches completion. Using the phonetic code requires the reader to apply rules converting a string of graphemes into its phonological representation. This would seem to be more consuming of STM than would a visual code. A phonetic code would be used by beginning readers who did not have access to a visual code and the able reader who was reading unfamiliar material (Andrews, 1982; McCusker, Hillinger & Bias, 1981).

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Table 1. Mean Number of Recognition Errors for All groups

Fifth Graders

	Good Readers			Poor Readers			
	Phonetically Similar	Phonetically Dissimilar	Both	Phonetically Similar	Phonetically Dissimilar	Both	Total
Aural Input	8.67	7.80	8.23	8.67	7.47	8.07	8.15
Visual Input	5.27	4.73	5.00	4.47	4.33	4.40	4.70
Both	6.97	6.27	6.62	6.57	5.90	6.24	6.43

Sixth Graders

	Good Readers			Poor Readers			
	Phonetically Similar	Phonetically Dissimilar	Both	Phonetically Similar	Phonetically Dissimilar	Both	Total
Aural Input	8.87	8.73	8.80	9.13	8.20	8.67	8.74
Visual Input	4.80	5.73	5.27	3.67	3.40	3.53	4.40
Both	6.83	7.23	7.03	6.40	5.80	6.10	6.57
Total	6.90	6.75	6.83	6.49	5.85	6.17	6.50

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